(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 132 884 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.09.2001 Bulletin 2001/37

(51) Int Cl.7: G09G 3/34

(21) Application number: 01302247.0

(22) Date of filing: 12.03.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 10.03.2000 JP 2000067778
25.12.2000 JP 2000393396

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(54) Display system and method for displaying still and moving picture data

(57) A display system comprises an interface circuit (706) for receiving various data from a network (704) to make output to a downstream circuit system; a data separation circuit (708) for making separation from data outputted from the interface circuit (706) into a file (still picture file and moving picture file) concerning image and control data; an output control circuit (710) for making control (control for still picture and control for moving picture) for a display controller (228), for example, in a unit of display component (14) on the basis of the control data from the data separation circuit (708); and a compressed file decoder circuit (712) installed upstream from an image data-processing circuit (224), for expanding the compressed file concerning image to make restoration into still picture data and moving picture data.

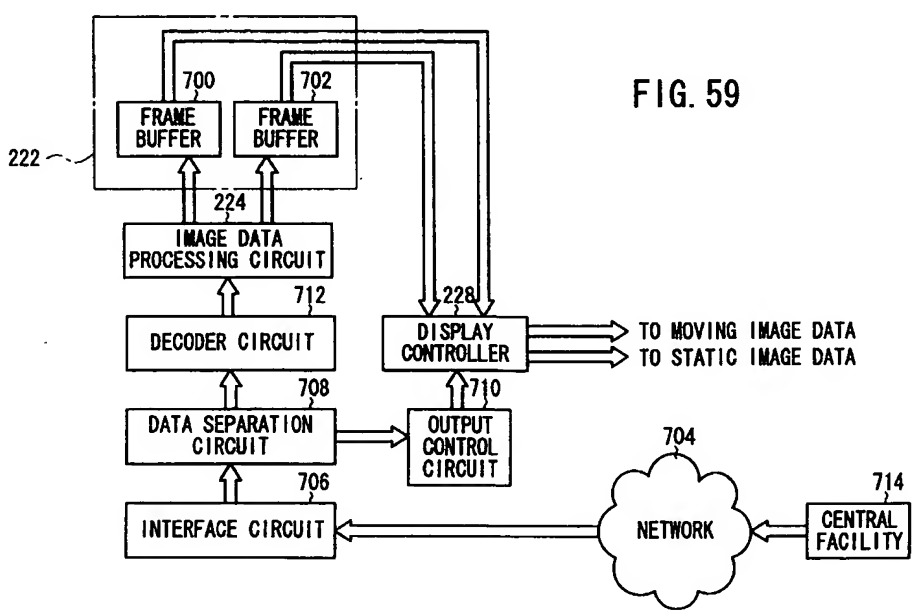

FIG. 59

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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] The present invention relates to a display system including a display and a method for managing a display. In particular, the present invention relates to a display system and a method for managing a display, which are preferably applied, for example, to a display for displaying a screen image corresponding to an image signal on an optical guide plate by controlling a displacement action of an actuator element in a direction to make contact or separation with respect to the optical guide plate in accordance with an attribute of the image signal to be inputted so that leakage light is controlled at a predetermined portion of the optical guide plate.

Description of the Related Art:

[0002] Those hitherto known as the display device include, for example, display devices such as cathode ray tubes (CRT), liquid crystal display devices, and plasma displays.

[0003] Those known as the cathode ray tube include, for example, ordinary television receivers and monitor units for computers. Although the cathode ray tube has a bright screen, it consumes a large amount of electric power. Further, the cathode ray tube involves such a problem that the depth of the entire display device is large as compared with the size of the screen. The cathode ray tube also involves, for example, such problems that the resolution is deteriorated at the peripheral portion of a displayed image, the image or the graphic is distorted, the memory function is not effected, and it is impossible to make a large display, because of the following reason.

[0004] That is, the electron beam, which is radiated from the electron gun, is greatly deflected. Therefore, the light emission spot (beam spot) is widened at the portion at which the electron beam arrives at the fluorescent screen of the Braun tube, and the image is displayed obliquely. As a result, the distortion occurs in the displayed image. Further, there is a certain limit to maintain the large space in the Braun tube in vacuum.

[0005] On the other hand, the liquid crystal display device is advantageous in that the entire device can be miniaturized, and the display device consumes a small amount of electric power. However, the liquid crystal display device involves problems such that it is inferior in luminance of the screen, and the field angle of the screen is narrow. Further, the liquid crystal display device involves such a difficulty that the arrangement of a driving circuit is extremely complicated, because the gradational expression is performed based on the voltage level.

[0006] For example, when a digital data line is used, the driving circuit therefor comprises a latching circuit for holding component RGB data (each 8-bit) for a predetermined period of time, a voltage selector, a multiplexer for making changeover to a voltage level of a type corresponding to a number of gradations, and an output circuit for adding output data from the multiplexer to the digital data line. In this case, when the number of gradations is increased, it is necessary to perform the switching operation at an extremely large number of levels in the multiplexer. The circuit construction is complicated in accordance therewith.

[0007] When an analog data line is used, the driving circuit therefor comprises a shift register for aligning, in the horizontal direction, component RGB data (each 8-bit) to be successively inputted, a latching circuit for holding parallel data from the shift register for a predetermined period of time, a level shifter for adjusting the voltage level, a D/A converter for converting output data from the level shifter into an analog signal, and an output circuit for adding the output signal from the D/A converter to the analog data line. In this case, a predetermined voltage corresponding to the gradation is obtained by using an operational amplifier in the D/A converter. However, when the range of the gradation is widened, it is necessary to use an operational amplifier which outputs a highly accurate voltage, resulting in such drawbacks that the structure is complicated and the price is expensive as well.

[0008] The plasma display has the following advantages. That is, it is possible to realize a small size, because the display section itself occupies a small volume. Further, the display is comfortably viewed, because the display surface is flat. Especially, the alternating current type plasma display also has such an advantage that it is unnecessary to use any refresh memory owing to the memory function of the cell.

[0009] As for the plasma display described above, in order to allow the cell to have the memory function, it is necessary to continue the electric discharge by switching the polarity of the applied voltage in an alternating manner. For this purpose, it is necessary to provide a first pulse generator for generating the sustain pulse in the X direction, and a second pulse generator for generating the sustain pulse in the Y direction. The plasma display involves such a problem that the arrangement of the driving circuit is inevitably complicated.

[0010] On the other hand, in order to solve the problems concerning the CRT, the liquid crystal display device, and the plasma display as described above, the present applicant has suggested a novel display device (see, for example, Japanese Laid-Open Patent Publication No. 7-287176). As shown in FIG. 74, this display device includes actuator elements 1000 which are arranged for respective picture elements. Each of the actuator elements 1000 comprises a main actuator element 1008 including a piezoelectric/electrostrictive layer 1002 and an upper electrode 1004 and a lower electrode 1006 formed on upper and lower surfaces of the

piezoelectric/electrostrictive layer 1002 respectively, and a substrate 1014 including a vibrating section 1010 and a fixed section 1012 disposed under the main actuator element 1008. The lower electrode 1006 of the main actuator element 1008 contacts with the vibrating section 1010. The main actuator element 1008 is supported by the vibrating section 1010.

[0011] The substrate 1014 is composed of ceramics in which the vibrating section 1010 and the fixed section 1012 are integrated into one unit. A recess 1016 is formed in the substrate 1014 so that the vibrating section 1010 is thin-walled.

[0012] A displacement-transmitting section 1020 for obtaining a predetermined size of contact area with respect to an optical guide plate 1018 is connected to the upper electrode 1004 of the main actuator element 1008. In the illustrative display device shown in FIG. 74, the displacement-transmitting section 1020 is arranged such that it is located closely near to the optical guide plate 1018 in the ordinary state in which the actuator element 1000 stands still, while it contacts with the optical waveguide plate 1018 in the excited state at a distance of not more than the wavelength of the light.

[0013] The light 1022 is introduced, for example, from a lateral end of the optical guide plate 1018. In this arrangement, all of the light 1022 is totally reflected at the inside of the optical guide plate 1018 without being transmitted through front and back surfaces thereof by controlling the magnitude of the refractive index of the optical guide plate 1018. In this state, a voltage signal corresponding to an attribute of an image signal is selectively applied to the actuator element 1000 by the aid of the upper electrode 1004 and the lower electrode 1006 so that the actuator element 1000 is allowed to stand still in the ordinary state or make displacement in the excited state. Thus, the displacement-transmitting section 1020 is controlled for its contact and separation with respect to the optical guide plate 1018. Accordingly, the scattered light (leakage light) 1024 is controlled at a predetermined portion of the optical guide plate 1018, and a screen image corresponding to the image signal is displayed on the optical guide plate 1018.

[0014] This display device has, for example, the following advantages. That is, (1) it is possible to decrease the electric power consumption, (2) it is possible increase the screen luminance, and (3) it is unnecessary to increase the number of picture elements (image pixels) as compared with the black-and-white screen when a color screen is constructed.

[0015] For example, as shown in FIG. 75, the peripheral circuit of the display device as described above comprises a display section 1030 in which a large number of picture elements are arranged, a vertical shift circuit 1034 provided with vertical selection lines 1032 which are led in a number corresponding to necessary rows and which are common for a large number of picture elements (picture element group) for constructing one row, and a horizontal shift circuit 1038 provided with signal lines 1036 which are led in a number corresponding to necessary columns and which are common for a large number of picture elements (picture element group) for constructing one column.

[0016] As for the display device as described above, a large screen display is constructed by arranging a large number of display devices in some cases. In such a case, the form of display on a large screen is either a still picture or a moving picture.

[0017] In the maintenance for the conventional large screen display, a maintenance operator goes hurriedly to the working site to make repair even in the case of any simple operation. Therefore, the cost required for the maintenance is extremely expensive, which is unfavorable to popularize the display.

SUMMARY OF THE INVENTION

[0018] The present invention has been made taking the foregoing problems into consideration, an object of which is to provide a display system and a method for managing a display, which make it possible to make display in which a still picture and a moving picture exist in a mixed manner.

[0019] Another object of the present invention is to provide a display system and a method for managing a display, which make it possible to easily perform, for example, the maintenance for a single large screen display or a plurality of large screen displays, for example, via a network so as to successfully contribute to the popularization of the large screen display.

[0020] According to the present invention, there is provided a display system comprising a display; and a display area-separating section for separating a display area of the display into a moving picture display area and a still picture display area.

[0021] Accordingly, it is possible to perform the display in which the still picture and the moving picture exist in a mixed manner. It is possible to diversify the display form.

[0022] It is also preferable that when the display is constructed by arranging a large number of display components; the display area-separating section separates the display area of the display into the moving picture display area and the still picture display area on the basis of address data to indicate the display components. In this arrangement, the moving picture display area and the still picture display area can be changed arbitrarily and easily. For example, when the display is used for the purpose of advertisement or the like, it is possible to easily realize a display form which conforms to the demand of the owner of the advertisement.

[0023] In this arrangement, it is also preferable that the display area-separating section is subjected to collective centralized control by a central facility connected to a network. By doing so, the moving picture display area and the still picture display area can be arbitrarily changed in a collective manner respectively for a plural-

ity of displays installed at a variety of districts. The management of the display is greatly simplified.

[0024] According to another aspect of the present invention, there is provided a display system comprising a display; a monitoring section for monitoring a power source current of the display; and a collective failure-diagnosing section for transmitting status information obtained by the monitoring section via a network to a central facility.

[0025] Accordingly, it is possible to collectively monitor the failure states of a plurality of displays installed at a variety of districts. It is possible to quickly respond to the failure.

[0026] According to still another aspect of the present invention, there is provided a display system comprising a display; and a driving voltage-adjusting section for adjusting a driving voltage supplied to the display to compensate decrease in luminance.

[0027] In this arrangement, it is unnecessary for a person who performs the maintenance to correct the luminance one by one. The display can be managed easily and reliably.

[0028] Especially, when the driving voltage-adjusting section is subjected to collective centralized control by a central facility connected to a network, it is possible to collectively correct the luminance for a plurality of displays installed at a variety of districts. Therefore, it is possible to greatly reduce the operation concerning the correction of the luminance.

[0029] It is also preferable that the driving voltage-adjusting section is schedule-managed by the aid of a timer. In this arrangement, for example, the luminance can be corrected by designating the midnight or the like. Therefore, it is unnecessary that the luminance of the display is corrected in a state of being viewed by any person. It is possible to avoid, for example, such an inconvenience that the display state of a certain advertisement is in a bad condition.

[0030] It is also preferable that when the display is a display comprising an optical guide plate for introducing light from a light source thereinto, and a driving section provided opposingly to a first plate surface of the optical guide plate and arranged with actuator elements of a number corresponding to a large number of picture elements, wherein a screen image corresponding to an image signal is displayed on the optical guide plate by controlling a displacement action of the actuator element in a direction to make contact or separation with respect to the optical guide plate in accordance with an attribute of the image signal to be inputted so that leakage light is controlled at a predetermined portion of the optical guide plate; the driving voltage-adjusting section adjusts the driving voltage on the basis of a displacement state of arbitrary one of the actuator elements.

[0031] It is also preferable that the driving voltage-adjusting section adjusts the driving voltage on the basis of a light emission luminance in a predetermined state of the display.

[0032] According to still another aspect of the present invention, there is provided a display system comprising a display comprising an optical guide plate for introducing light from a light source thereinto, and a driving section provided opposingly to a first plate surface of the optical guide plate and arranged with actuator elements of a number corresponding to a large number of picture elements, wherein a screen image corresponding to an image signal is displayed on the optical guide plate by controlling a displacement action of the actuator element in a direction to make contact or separation with respect to the optical guide plate in accordance with an attribute of the image signal to be inputted so that leakage light is controlled at a predetermined portion of the optical guide plate; a preliminary light source; a current-monitoring section for monitoring a current of the light source; and a preliminary light source control unit for selectively turning on or turning off the preliminary light source on the basis of information from the current-monitoring section.

[0033] Accordingly, in an unexpected situation, for example, when the light source is subjected to any disconnection, or when the luminance is suddenly decreased, the preliminary light source is selectively turned on to avoid the disconnection of the light source and the decrease in luminance. Therefore, it is possible to maintain the presentation on the display during a period from the point of time of the occurrence of the deficiency until the maintenance is started.

[0034] It is also preferable that a part or all of the preliminary light sources are a preliminary light source provided for the purpose of countermeasure for fading. It is also preferable that the display system further comprises a cooling fan; and a cooling control unit for selectively driving the cooling fan on the basis of selective turning on of the preliminary light source. Accordingly, it is possible to suppress the sudden temperature change. It is possible to use the display system for a long period of time. Further, it is possible to suppress, for example, uneven luminance which would be otherwise caused by the temperature change.

[0035] According to still another aspect of the present invention, there is provided a display system comprising a display; a memory for storing luminance correction data for correcting a luminance dispersion of the display; and a table creation mechanism for rewriting the luminance correction data.

[0036] Accordingly, even when the luminance characteristic is changed due to the time-dependent change or the temperature change, it is possible to rewrite the luminance correction data corresponding to the change. Therefore, it is possible to maintain the display luminance at approximately the same level as that at the initial stage.

[0037] It is also preferable that the table creation mechanism is subjected to collective centralized control by a central facility connected to a network. Alternatively, it is also preferable that the table creation mechanism

is schedule-managed by the aid of a timer.

[0038] It is also preferable that when the display is a display comprising an optical guide plate for introducing light from a light source thereinto, and a driving section provided opposingly to a first plate surface of the optical guide plate and arranged with actuator elements of a number corresponding to a large number of picture elements, wherein a screen image corresponding to an image signal is displayed on the optical guide plate by controlling a displacement action of the actuator element in a direction to make contact or separation with respect to the optical guide plate in accordance with an attribute of the image signal to be inputted so that leakage light is controlled at a predetermined portion of the optical guide plate; the table creation mechanism rewrites the luminance correction data on the basis of a displacement state of arbitrary one of the actuator elements.

[0039] In this arrangement, it is also preferable that the table creation mechanism rewrites the luminance correction data on the basis of a light emission luminance in a predetermined state of the display. Further, it is also preferable that the table creation mechanism rewrites the luminance correction data also in consideration of color balance adjustment.

[0040] According to still another aspect of the present invention, there is provided a display system comprising a display comprising an optical guide plate for introducing light from a light source thereinto, and a driving section provided opposingly to a first plate surface of the optical guide plate and arranged with actuator elements of a number corresponding to a large number of picture elements, wherein a screen image corresponding to an image signal is displayed on the optical guide plate by controlling a displacement action of the actuator element in a direction to make contact or separation with respect to the optical guide plate in accordance with an attribute of the image signal to be inputted so that leakage light is controlled at a predetermined portion of the optical guide plate, and wherein the actuator element makes the displacement action in a first direction when a voltage of positive polarization or negative polarization with respect to a reference electric potential is applied; and a switching means for making changeover to the voltage of positive polarization or the voltage of negative polarization at an arbitrary timing.

[0041] Accordingly, even when the response speed of the actuator element is decreased, or any unsuccessful separation takes place, then the changeover is made to the voltage of positive polarization or the voltage of negative polarization by the aid of the switching means. Therefore, the displacement ability of the actuator element is restored, and it is possible to restore the response speed to that at the initial stage.

[0042] It is also preferable that the switching means is subjected to collective centralized control by a central facility connected to a network. Alternatively, it is also preferable that the switching means is schedule-managed by the aid of a timer.

[0043] The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which a preferred embodiment of the present invention is shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] FIG. 1 shows a perspective view illustrating a schematic arrangement of a display to which a display system according to an embodiment of the present invention is applied;

[0045] FIG. 2 shows a sectional view illustrating an arrangement of a display component;

[0046] FIG. 3 illustrates an arrangement of picture elements of the display component;

[0047] FIG. 4 shows a sectional view depicting a first illustrative arrangement of an actuator element and a picture element assembly;

[0048] FIG. 5 shows an example of a planar configuration of a pair of electrodes formed on the actuator element;

[0049] FIG. 6A illustrates an example in which comb teeth of the pair of electrodes are arranged along the major axis of a shape-retaining layer;

[0050] FIG. 6B illustrates another example;

[0051] FIG. 7A illustrates an example in which comb teeth of the pair of electrodes are arranged along the minor axis of a shape-retaining layer;

[0052] FIG. 7B illustrates another example;

[0053] FIG. 8 shows a sectional view illustrating another arrangement of a display component;

[0054] FIG. 9 shows a sectional view depicting a second illustrative arrangement of an actuator element and a picture element assembly;

[0055] FIG. 10 shows a sectional view depicting a third illustrative arrangement of an actuator element and a picture element assembly;

[0056] FIG. 11 shows a sectional view depicting a fourth illustrative arrangement of an actuator element and a picture element assembly;

[0057] FIG. 12 illustrates an arrangement obtained when crosspieces are formed at four corners of the picture element assemblies respectively;

[0058] FIG. 13 illustrates another arrangement of the crosspiece;

[0059] FIG. 14 shows a table illustrating the relationship concerning the offset potential (bias potential) outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between a row electrode and a column electrode;

[0060] FIG. 15 shows a circuit diagram illustrating an arrangement of a driving unit according to first and second embodiments;

[0061] FIG. 16 shows a block diagram illustrating an arrangement of a driver IC of a column electrode-driving circuit of the driving unit according to the first embodiment;

[0062] FIG. 17 especially shows an example in which one frame is divided into a plurality of subfields in order to explain the gradation control in the driving unit according to the first embodiment;

[0063] FIG. 18 shows a block diagram illustrating a signal processing circuit of the driving unit according to the first embodiment;

[0064] FIG. 19 shows a table illustrating another example of the relationship concerning the offset potential (bias potential) outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between a row electrode and a column electrode;

[0065] FIG. 20 shows a table illustrating still another example of the relationship concerning the offset potential (bias potential) outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between a row electrode and a column electrode;

[0066] FIG. 21 especially shows an example in which one frame is equally divided into a plurality of linear subfields in order to explain the gradation control in the driving unit according to the second embodiment;

[0067] FIG. 22A illustrates a bit array in which the gradation level is 62 in dot data prepared by the driving unit according to the second embodiment;

[0068] FIG. 22B illustrates a bit array in which the gradation level is 8 as well;

[0069] FIG. 23 shows a block diagram illustrating a signal processing circuit in a driving unit according to second and fourth embodiments;

[0070] FIG. 24 shows a block diagram illustrating an arrangement of a driver IC to be used for the driving unit according to the second embodiment;

[0071] FIG. 25 shows a block diagram illustrating an arrangement of a data transfer section to be used for the driving unit according to the second embodiment;

[0072] FIG. 26 illustrates data division in a first data output circuit;

[0073] FIG. 27 illustrates the data transfer form from the first data output circuit to the second data output circuit; FIG. 28 shows a circuit diagram illustrating an arrangement of a driving unit according to third and fourth embodiments;

[0074] FIG. 29 especially shows an example in which one frame is divided into two fields and one field is divided into a plurality of subfields in order to explain the gradation control in the driving unit according to the third embodiment;

[0075] FIG. 30 shows a block diagram illustrating a signal processing circuit in the driving unit according to the third embodiment;

[0076] FIG. 31 shows a table illustrating the relationship concerning the electric potentials of a select signal and an nonselect signal outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between the row electrode and the column electrode;

[0077] FIG. 32 shows a table illustrating another example of the relationship concerning the electric potentials of a select signal and an nonselect signal outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between the row electrode and the column electrode;

[0078] FIG. 33 shows a table illustrating still another example of the relationship concerning the electric potentials of a select signal and an nonselect signal outputted from a row electrode drive circuit, the electric potentials of an ON signal and an OFF signal outputted from a column electrode-driving circuit, and the voltage applied between the row electrode and the column electrode;

[0079] FIG. 34 especially shows an example in which one frame is divided into two fields and one field is equally divided into a plurality of linear subfields in order to explain the gradation control in the driving unit according to the fourth embodiment;

[0080] FIG. 35 shows a block diagram illustrating a signal processing circuit in the driving unit according to the fourth embodiment;

[0081] FIG. 36 illustrates an arrangement of picture elements of a display component to which a driving unit according to a fifth embodiment is applied;

[0082] FIG. 37 especially shows an example in which one frame is divided into three fields and one field is divided into a plurality of subfields in order to explain the gradation control in the driving unit according to the fifth embodiment;

[0083] FIG. 38 shows a circuit diagram illustrating an arrangement of a driving unit according to fifth and sixth embodiments;

[0084] FIG. 39 shows a block diagram illustrating a signal processing circuit in the driving unit according to the fifth embodiment;

[0085] FIG. 40 especially shows an example in which one frame is divided into three field and one field is equally divided into a plurality of linear subfields in order to explain the gradation control in the driving unit according to the sixth embodiment;

[0086] FIG. 41 shows a block diagram illustrating a signal processing circuit in the driving unit according to the sixth embodiment;

[0087] FIG. 42A shows a sectional view illustrating an example of a display component based on the use of static electricity depicting a case in which the display component is in a light emission state;

[0088] FIG. 42B shows a sectional view depicting a case in which the display component is in a light off

state;

[0089] FIG. 43A shows a sectional view illustrating another example of a display component based on the use of static electricity depicting a case in which the display component is in a light emission state;

[0090] FIG. 43B shows a sectional view depicting a case in which the display component is in a light off state;

[0091] FIG. 44 shows a sectional view illustrating another arrangement of an actuator element;

[0092] FIG. 45 shows a block diagram for illustrating a luminance-correcting means;

[0093] FIG. 46 shows a characteristic illustrating an example of luminance distribution of respective dots;

[0094] FIG. 47 shows a characteristic illustrating another example of luminance distribution of respective dots;

[0095] FIG. 48 shows a block diagram for illustrating a linear correcting means;

[0096] FIG. 49A shows a light emission luminance characteristic of a certain dot;

[0097] FIG. 49B shows a characteristic illustrating a weighting factor for linearizing the light emission luminance characteristic;

[0098] FIG. 49C shows a characteristic illustrating a light emission luminance distribution after being linearized;

[0099] FIG. 50A shows a light emission luminance characteristic of a television signal applied with gamma control;

[0100] FIG. 50B shows a characteristic illustrating a weighting factor for counteracting the gamma control;

[0101] FIG. 50C shows a characteristic illustrating a light emission luminance distribution after being linearized;

[0102] FIG. 51 shows a block diagram for illustrating a dimming control means;

[0103] FIG. 52A shows a timing chart illustrating an example of the timing for switching the light source;

[0104] FIG. 52B shows a timing chart illustrating an example of the combination of linear subfields selected depending on the gradation level;

[0105] FIG. 53A shows a timing chart illustrating another example of the timing for switching the light source;

[0106] FIG. 53B shows a timing chart illustrating another example of the combination of linear subfields selected depending on the gradation level;

[0107] FIG. 54A shows a waveform illustrating a signal applied to the column electrode in the ordinary driving;

[0108] FIG. 54B shows a waveform illustrating a signal applied to the row electrode;

[0109] FIG. 54C shows a waveform illustrating a voltage applied to the dot;

[0110] FIG. 55A shows an applied voltage waveform in the ordinary operation;

[0111] FIG. 55B shows a light intensity distribution thereof;

[0112] FIG. 56A shows a waveform illustrating a signal applied to the column electrode when the preparatory period is provided;

[0113] FIG. 56B shows a waveform illustrating a signal applied to the row electrode;

[0114] FIG. 56C shows a waveform illustrating a voltage applied to the dot;

[0115] FIG. 57A shows an applied voltage waveform when the preparatory period is provided;

[0116] FIG. 57B shows a light intensity distribution thereof;

[0117] FIG. 58 shows an example of the circuit used for the row electrode drive circuit;

[0118] FIG. 59 shows a block diagram illustrating a display system according to a first embodiment;

[0119] FIG. 60 shows a block diagram illustrating a display system according to a second embodiment;

[0120] FIG. 61 shows a block diagram illustrating a display system according to a third embodiment;

[0121] FIG. 62 shows a block diagram illustrating a first modified embodiment of the display system according to the third embodiment;

[0122] FIG. 63 shows a block diagram illustrating a second modified embodiment of the display system according to the third embodiment;

[0123] FIG. 64 shows a block diagram illustrating a display system according to a fourth embodiment;

[0124] FIG. 65 shows a block diagram illustrating a display system according to a fifth embodiment;

[0125] FIG. 66 shows the relationship between the angle of visibility and the areal size of measurement by a luminance meter;

[0126] FIG. 67 shows characteristics illustrating the result of measurement of the relative luminance value with respect to the angle of visibility;

[0127] FIG. 68 shows a characteristic illustrating a displacement characteristic of the actuator element;

[0128] FIG. 69A shows a voltage waveform applied to the actuator element;

[0129] FIG. 69B shows a displacement characteristic of the actuator element with respect to the applied voltage;

[0130] FIG. 70 shows, with partial omission, a perspective view illustrating a display based on the divided panel system;

[0131] FIG. 71 shows a chromaticity characteristic of the display according to the embodiment of the present invention;

[0132] FIG. 72 depicts a first illustrative arrangement of the display based on the divided panel system;

[0133] FIG. 73 depicts a second illustrative arrangement of the display based on the divided panel system;

[0134] FIG. 74 shows an arrangement illustrating a display device concerning a suggested example; and

[0135] FIG. 75 shows a block diagram illustrating a peripheral circuit of the display device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0136] Illustrative embodiments of the display system and the method for managing the display according to the present invention will be explained below with reference to FIGS. 1 to 73. Prior thereto, explanation will be made with reference to FIGS. 1 to 13 for an arrangement of a display to which the display system and the method for managing the display according to the present invention are applied.

[0137] As shown in FIG. 1, the display 10 comprises a plurality of display components 14 arranged on a back surface of an optical waveguide plate 12 having a display area as the display 10.

[0138] As shown in FIG. 2, each of the display components 14 comprises an optical guide plate 20 for introducing light 18 from a light source 16 thereinto, and a driving section 24 provided opposingly to the back surface of the optical guide plate 20 and including a large number of actuator elements 22 which are arranged corresponding to picture elements (image pixels) in a matrix configuration or in a zigzag configuration.

[0139] The arrangement of the picture element array is as follows, for example, as shown in FIG. 3. That is, one dot 26 is constructed by two actuator elements 22 which are aligned in the vertical direction. One picture element 28 is constructed by three dots 26 (red dot 26R, green dot 26G, and blue dot 26B) which are aligned in the horizontal direction. In the display component 14, the picture elements 28 are aligned such that sixteen individuals (48 dots) are arranged in the horizontal direction, and sixteen individuals (16 dots) are arranged in the vertical direction.

[0140] In the display 10, as shown in FIG. 1, for example, in order to conform to the VGA standard, forty individuals of the display components 14 are arranged in the horizontal direction, and thirty individuals of the display components 14 are arranged in the vertical direction on the back surface of the optical waveguide plate 12 so that 640 picture elements (1920 dots) are aligned in the horizontal direction, and 480 picture elements (480 dots) are aligned in the vertical direction.

[0141] Those which are uniform and which have a large light transmittance in the visible light region, such as glass plates and acrylic plates are used for the optical waveguide plate 12. The respective display components 14 are mutually connected to one another, for example, by means of wire bonding, soldering, end surface connector, or back surface connector so as to make it possible to supply signals between the mutual display components 14.

[0142] It is preferable that the refractive index of the optical waveguide plate 12 is similar to that of the optical guide plate 20 of each of the display components 14. When the optical waveguide plate 12 and the optical waveguide plates 20 are bonded to one another, it is also preferable to use a transparent adhesive. Preferably, the adhesive is uniform and it has a high transmittance in the visible light region in the same manner as the optical waveguide plate 12 and the optical guide plate 20. It is also desirable that the refractive index of the adhesive is set to be similar to those of the optical waveguide plate 12 and the optical guide plate 20 in order to ensure the brightness of the screen.

[0143] In each of the display components 14, as shown in FIG. 2, a picture element assembly 30 is stacked on each of the actuator elements 22. The picture element assembly 30 functions such that the contact area with the optical guide plate 20 is increased to give an areal size corresponding to the picture element.

[0144] The driving section 24 includes an actuator substrate 32 composed of, for example, ceramics. The actuator elements 22 are arranged at positions corresponding to the respective picture elements 28 on the actuator substrate 32. The actuator substrate 32 has its first principal surface which is arranged to oppose to the back surface of the optical guide plate 20. The first principal surface is a continuous surface (flushed surface). Hollow spaces 34 for forming respective vibrating sections as described later on are provided at positions corresponding to the respective picture elements 28 at the inside of the actuator substrate 32. The respective hollow spaces 34 communicate with the outside via through-holes 36 each having a small diameter and provided at the second principal surface of the actuator substrate 32.

[0145] The portion of the actuator substrate 32, at which the hollow space 34 is formed, is thin-walled. The other portion of the actuator substrate 32 is thick-walled. The thin-walled portion has a structure which tends to undergo vibration in response to external stress, and it functions as a vibrating section 38. The portion other than the hollow space 34 is thick-walled, and it functions as a fixed section 40 for supporting the vibrating section 38.

[0146] That is, the actuator substrate 32 has a stacked structure comprising a substrate layer 32A as a lowermost layer, a spacer layer 32B as an intermediate layer, and a thin plate layer 32C as an uppermost layer. The actuator substrate 32 can be recognized as an integrated structure including the hollow spaces 34 formed at the positions in the spacer layer 32B corresponding to the actuator elements 22. The substrate layer 32A functions as a substrate for reinforcement, as well as it functions as a substrate for wiring. The actuator substrate 32 may be sintered in an integrated manner, or it may be additionally attached.

[0147] Specified embodiments of the actuator element 22 and the picture element assembly 30 will now be explained with reference to FIGS. 4 to 13. The embodiments shown in FIGS. 4 to 13 are illustrative of a case in which a gap-forming layer 44 is provided between the optical guide plate 20 and a crosspiece 42 as described later on.

[0148] At first, as shown in FIG. 4, each of the actuator

elements 22 comprises the vibrating section 38 and the fixed section 40 described above, as well as a shape-retaining layer 46 composed of, for example, a piezoelectric/electrostrictive layer or an anti-ferroelectric layer directly formed on the vibrating section 38, and a pair of electrodes 48 (a row electrode 48a and a column electrode 48b) formed on an upper surface and a lower surface of the shape-retaining layer 46.

[0149] As shown in FIG. 4, the pair of electrodes 48 may have a structure in which they are formed on upper and lower sides of the shape-retaining layer 46, or they are formed on only one side of the shape-retaining layer 46. Alternatively, the pair of electrodes 48 may be formed on only the upper portion of the shape-retaining layer 46.

[0150] When the pair of electrodes 48 are formed on only the upper portion of the shape-retaining layer 46, the planar configuration of the pair of electrodes 48 may be a shape in which a large number of comb teeth are opposed to one another in a complementary manner as shown in FIG. 5. Alternatively, it is possible to adopt, for example, the spiral configuration and the branched configuration as disclosed in Japanese Laid-Open Patent Publication No. 10-78549 as well.

[0151] When the planar configuration of the shape-retaining layer 46 is, for example, an elliptic configuration, and the pair of electrodes 48 are formed to have a comb teeth-shaped configuration, then it is possible to use, for example, a form in which the comb teeth of the pair of electrodes 48 are arranged along the major axis of the shape-retaining layer 46 as shown in FIGS. 6A and 6B, and a form in which the comb teeth of the pair of electrodes 48 are arranged along the minor axis of the shape-retaining layer 46 as shown in FIGS. 7A and 7B.

[0152] It is possible to use, for example, the form in which the comb teeth of the pair of electrodes 48 are included in the planar configuration of the shape-retaining layer 46 as shown in FIGS. 6A and 7A, and the form in which the comb teeth of the pair of electrodes 48 protrude from the planar configuration of the shape-retaining layer 48 as shown in FIGS. 6B and 7B. The forms shown in FIGS. 6B and 7B are more advantageous to effect the bending displacement of the actuator element 22.

[0153] As shown in FIG. 4, for example, when the pair of electrodes 48 are constructed such that the row electrode 48a is formed on the upper surface of the shape-retaining layer 46, and the column electrode 48b is formed on the lower surface of the shape-retaining layer 46, the actuator element 22 can be subjected to bending displacement in a first direction so that it is convex toward the hollow space 34 as shown in FIG. 2. Alternatively, as shown in FIG. 8, the actuator element 22 can be subjected to bending displacement in a second direction so that it is convex toward the optical guide plate 20. The example shown in FIG. 8 is illustrative of a case in which the gap-forming layer 44 (see FIG. 4) is not formed.

[0154] On the other hand, as shown in FIG. 4, for example, the picture element assembly 30 can be constructed by a stack comprising a white scattering element 50 as a displacement-transmitting section formed on the actuator element 22, a color filter 52, and a transparent layer 54.

[0155] Further, as shown in FIG. 9, a light-reflective layer 56 may be allowed to intervene as a lower layer of the white scattering element 50. In this arrangement, it is desirable that an insulative layer 58 is formed between the light-reflective layer 56 and the actuator element 22.

[0156] Another example of the picture element assembly 30 is, for example, as shown in FIG. 10. That is, the picture element assembly 30 can be also constructed by a stack comprising a color scattering element 60 to also serve as a displacement-transmitting section formed on the actuator element 22, and a transparent layer 54. Also in this case, as shown in FIG. 11, a light-reflective layer 56 and an insulative layer 58 may be allowed to intervene between the actuator element 22 and the color scattering element 60.

[0157] As shown in FIGS. 2, 4, and 8, the display component 14 comprises the crosspieces 42 which are formed at the portions other than the picture element assembly 30 between the optical guide plate 20 and the actuator substrate 32. The example shown in FIG. 8 is illustrative of a case in which the optical guide plate 20 is directly secured to the upper surfaces of the crosspieces 42. It is preferable that the material for the crosspiece 42 is not deformed by heat and pressure.

[0158] The crosspieces 42 can be formed, for example, at portions around four corners of the picture element assembly 30. The portions around four corners of the picture element assembly 30 are herein exemplified, for example, by positions corresponding to the respective corners as shown in FIG. 12, for example, when the picture element assembly 30 has a substantially rectangular or elliptic planar configuration. FIG. 12 is illustrative of a form in which one crosspiece 42 is shared by the adjoining picture element assembly 30.

[0159] Another example of the crosspiece 42 is shown in FIG. 13. That is, the crosspiece 42 may be provided with windows 42a each of which surrounds at least one picture element assembly 30. The representative illustrative arrangement is as follows. That is, for example, the crosspiece 42 itself is formed to have a plate-shaped configuration. Windows (openings) 42a, each having a shape similar to the outer configuration of the picture element assembly 30, are formed at the positions corresponding to the picture element assemblies 30. Accordingly, all of the side surfaces of the picture element assembly 30 are consequently surrounded by the crosspiece 42. Thus, the actuator substrate 32 and the optical guide plate 20 are secured to one another more tightly.

[0160] Explanation will now be made for the respective constitutive members of the display component 14, especially for the selection of the material or the like for